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ECG Signal Acquisition and ECG Data Transmission

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***Abstract*: Heart-related disorders are the most common health condition that can influence various aspects of life. Heart rate monitoring plays a vital role to predict health conditions. Telemedicine is providing health-related resources and information through telecommunications technology and electronic information. One of the most emerging trends in day-to-day life is the telemedicine system. This telemedicine system is evolving as a result of reducing the overall cost of the patient, in particular for disadvantaged patients and border area patients, by reducing travel allowances, hotel expenses, and the sum to be charged by specialists for some complicated illnesses. Patients do not need to consult with physicians with the use of telemedicine services, and patients may be able to obtain successful care from their locations or local hospitals.**

***Keywords*:** ECG, NodeMCU, Wi-Fi, IoT, Cloud, ESP8266, Blynk

I. *INTRODUCTION:*

The telehealth system is one which the most emerging trend in today's life. This telehealth system is emerging because of reducing the total cost of the patient especially for poor patients and the patients from border areas by reducing traveling allowances, accommodation charges, and the amount is required to meet the specialists for some complicated diseases. With the help of the telehealth systems, the patients may not need to meet the specialists or the diagnostic persons and the patients can get effective treatments by sitting in their places. Because of these reasons, the people from villages are interested in telehealth systems.

In this telehealth system, the patients are not needed to meet the specialists or diagnostic person continuously until their problems get solved. Some data acquisition nodes depend upon the disease of the patients will be placed with the patient's body and the acquired data will be transmitted to the specialists or diagnostic persons by the communication nodes. These communication nodes could also be a GSM technique or CDMA technique or otherwise could be wireless local area networks (WLAN) like Bluetooth, ZIGBEE, Wi-Fi, etc., The transmitted signals from the communication node will be received by the use of technology in the receiver end and then this signal will be monitored in the specialist's monitor. This detailed process will be done in the telehealth systems.

II. *METHODOLOGY:*

The proposed system consists of ECG Sensor, Arduino Microcontroller, WIFI module, Cloud or server, and MATLAB tool. It displays the extracted data or extracted parameters on the cloud through a WIFI module and WIFI access point for immediate access to the experts or doctors. Fig 2. shows a block diagram of the proposed system. The first electrodes capture the ECG signal and send it to the controller. The Arduino UNO is the controller used in this project, which processes the ECG signal and sends it to the WIFI module.

ESP8266 is used to send data to the cloud that is Thing Speak wirelessly. An acquired ECG data can be transmitted by using this cloud-based system. By using the Internet, doctors can be able to access the data from the cloud or server. Thing Speak cloud is the open Internet of Things (IoT) platform with MATLAB analytics used to visualize data to doctor or expert, then the doctor or expert's analyst makes decisions.

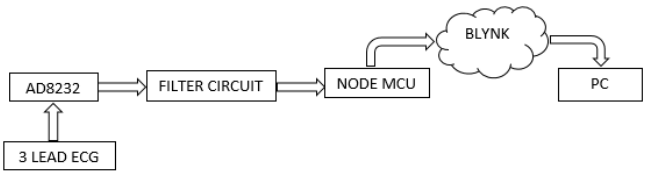

FIG .BLOCK DIAGRAM

III. *LITERATURE SURVEY:*

A literature review covering papers published. The search was conducted using the IEEE explorer, cited literature in the included articles, and various journals.

Mishra [1] has proposed the circuit, consisting of Arduino Uno, W-LAN module and the ECG sensor was well connected. The ECG leads are then color-coded and implanted on the patient's body. Now when the circuit is turned on, the heart rate is continuously monitored and an ECG waveform is generated.

The serial monitor receives the voltage value from the EKG at certain time intervals. The ECG curve is generated in the Arduino Uno's serial plotter, and the data is transferred over the internet to a specific website, where corresponding doctors can access it from anywhere in the world, thanks to the ESP 8266.. If there is some abnormality in the ECG waveform, that the QRS complex is not well defined, inversion of T-waves, very low amplitude level, then the physician is immediately notified using SMTP that there is a problem with this particular patient. The physician can then go on to the website, view the ECG graph, and take the required steps to enhance the patient's health.

Chede and Girhepunje [2] proposed a system composed of electrodes, AD8232 ECG module, MSP432P401R microcontroller, ESP12E WiFi module, and the receiver is composed of a laptop or personal computer. Three electrodes connected to the left arm, right arm, and left leg. Electrodes are used to capture ECG signals from the human body and given to the AD8232 ECG module. The AD8232 ECG module is used to monitor the heart's electrical activity. AD8232 amplifies the ECG signal coming from the human body with the help of electrodes and gives an amplified analog signal. The output of AD8232 is given to the MSP432P401R microcontroller. With the help of the Microcontroller's inbuilt analogue to digital converter, the AD8232's output is turned into a digital signal. Then with the help of programming some range of signals into the microcontroller is stored and with the help of a comparator which is inbuilt in the microcontroller compared the incoming signal with the predefined signal. If the incoming signal range is out of the predefined signal range, then the incoming signal passes towards the receiver. Otherwise, the signal will not be transmitted towards the receiver. The signal from the transmitter to the receiver is sent using the ESP12E Wi-Fi module, which has a 32-meter range. The received signal is displayed on the cardiologist's PC with the help of lab view software.

Bamarouf et al., [3] have proposed an embedded system that has been developed to facilitate real-time arrhythmia detection. It processes electrocardiogram (ECG) signals and sends a wireless message to the patient's doctor if Ventricular Tachycardia (VT) is detected. Signal processing includes first the Pan Tompkins algorithm for R peak detection, then the pattern matching algorithm for PVC detection. Using healthy beats, the pattern matching algorithm produces two samples, a QRS complex and an interval between two R peaks. The two templates are then correlated with the QRS complex and R-R interval of each heartbeat, and a low correlation indicates a PVC. The TI CC3200 LaunchPad, a low-cost Wi-Fi board, is used to implement all of the algorithms. A short-message-service (SMS) system is initiated when three or more consecutive PVCs are recognised. To send a text message from the LaunchPad to a cell phone, cloud-based apps are used. Design validation is based on benchmark records from the MIT-BIH arrhythmia database. The signal processing is simulated using MATLAB. The experimental results using the LaunchPad were 99.1% QRS sensitivity and 81.7% PVC sensitivity. This research provides a low-complexity, practical method for real-time heart monitoring and arrhythmia identification.

Yeri and Shubhangi [4] have proposed a model, the vital parameters for the patient are acquired by attaching to the patient's body. The data is sent to the cloud via the Wi-Fi module. The sensors are interfaced with the processor Arduino. If the patient desires, he or she is free to move around. A fingerprint sensor is used so that an authorized person can only access the data. The basic hardware connections of the system. The processor processes the data acquired by sensors and processed data is transferred to the cloud through a Wi-Fi module. The processed data can be seen on the webpage using the computer or the mobile. The real-time vital parameters are measured every 30seconds. The system is set up in such a way that if the parameter data exceeds the threshold values, an alarm message is sent to the doctor. The output of sensors is displayed on LCD. The data from the sensors is sent to the cloud and to the mobile app. The values of any of the sensor values cross the threshold an alert message is sent to the doctor. The doctor receiving an alert message.

Alfarhan et al., [5]- has proposed the system which is most widely used (Web Host Manager) WHM is the Ag/AgCl disposable electrode that is used once. The Ag/AgCl electrode might cause skin injury when used for long-term monitoring. Dry electrodes must be used to avoid damage. The electrodes collect very low amplitude cardiac signals ranging from 0.1mV to 5mV. As a result, these signals must be amplified hundreds of times with an analogue circuit. An instrumentation amplifier and filter make up the analogue circuit. The wireless heart monitor's instrumentation amplifier must have particular features, such as a high Common Mode Rejection Ratio (CMRR), low power consumption, and a low offset current, low input bias, and a fast rate. A low pass filter, notch filter 50-60 Hz, and band-pass filter are needed to filter these noisy signals. Usually, the WHMs work with rechargeable batteries. As a result, the WHM circuit must be designed with minimal power consumption in mind in order to extend the battery depletion period. WHM circuit design is known for its low power consumption consuming integrated circuits and on-chip filters. This CMOS ICs design has low power consumption. The ECG analogue circuit design may necessitate a significant amount of time and effort in terms of IC selection and design calculations. By employing ECG ICs, you can save time and effort. This includes an instrumentation amplifier, a MUX, a filter, an Analog to Digital Converter (ADC), serial communication, and other components.

Barata [6] has proposed the system in which the application is targeted to Smartphones and tablets that run the operating system Android. The Android application was programmed using Android Development Tools (ADT), a plugin for Eclipse, to use 1270 Daniel Barata et al. Procedia Technology 9 (2013) the Java programming language. Their programme has two unique functions: receiving data from medical devices and publishing data utilising MQ Telemetry Transport (MQTT) technology. After the application initialization there is a button to start the service to verify if the MQTT connection was established and, in case of success, the acquisition of health parameters can be initialized.

Hasan and Ismaeel [7] have proposed a system and the goal is to design an IoT-based ECG healthcare system for people suffering from heart problems. A free application called Blynk IoT is utilized by the system to monitor a patient's heart state automatically. The main advantages of the system are its ability to connect and be used by anyone, its portability, its remote capabilities, its cost-effectiveness, and its easy setting up. This system might be expanded in the future to include more electrodes for ECG sensors, as well as sensors for blood pressure and heartbeats. It will be very beneficial to create a cloud database that will store all the patient's health information, including their health history. However, every time the doctor performs a new ECG reading, the data will be directly stored into the patient's record in the cloud database.

Duran et al.[8] has proposed a system that controls and links home appliances using Node MCU ESP8266 controllers via WIFI. To facilitate monitoring and controlling various connected things, the iOS version of the Blynk app with a custom-designed layout and buttons was used for the user interface. The home appliances can be controlled remotely by pressing a virtual button on the smartphone. It has the advantage of being able to be shared with all members of the family. Each time a member turns an appliance ON or OFF, the action will be visible to all others who are sharing the app. The app also allows users to access real-time and historical data like temperature, humidity, GPS location, and distance measurements.

Xu [9] has proposed an IoT-assisted electrocardiogram (ECG) monitoring system with secure data transmission has been developed. IoT-assisted ECG monitoring system, the creation, and implementation of a lightweight ECG Signal Strength Analysis has been proposed for automatic classification and real-time implementation, employing ECG sensors, Arduino, Android phones, Bluetooth, and cloud servers. The Lightweight Secure IoT (LS-IoT) and Lightweight Access Control (LAC) protocols have been proposed for secure data transport. This has great potential to determine the clinical acceptance of ECG signals to improve the efficiency, accuracy, and reliability of an unsupervised diagnostic system.

Neyja et al. [10] have proposed a system based on the Internet of Things (IoT) Electro Cardio Gram and Hidden Markov Model (HMM) chain in the framework of e-Health, (ECG) sensors are used. To better monitoring and intervention in the event of emergency patients with cardiovascular diseases (CVD) will benefit from this. For such patients, medical services are available. Because real-time monitoring of patients from various places remains a major difficulty for IoT-based health care systems, this implementation uses a patient route estimator, a patient table, and alert management schemes inside the hospital to aid in the localization and treatment of CVD patients.

IV. *CONCLUSION:*

The design's primary blocks are finished at this point. The prototype is capable of acquiring almost approximate ECG signals with a very low noise margin. Any analogue signal can be converted to digital and transmitted wirelessly. Obtaining any data from the serial COM port of PC and importing them into Arduino IDE, Blynk, and other applications. Display of data on the Blynk app designed on the Windows platform. We have planned to incorporate aspects of basic health care examination such as heart rate, ECG analysis, and stress metre, taking into account all of the problems in remote healthcare. Further, the regenerated signal can be analyzed for different diagnostic purposes. Every step of the way, we've strived to keep the cost as low as possible by using widely available ICs and Bluetooth. Further, we have planned to make it compatible with android devices, which are readily and widely used nowadays. After further modification in the circuit and the addition of sensors to measure heart rate, body temperature, and blood pressure, etc. it'll be one of the most compact and low-cost devices in the healthcare sector

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